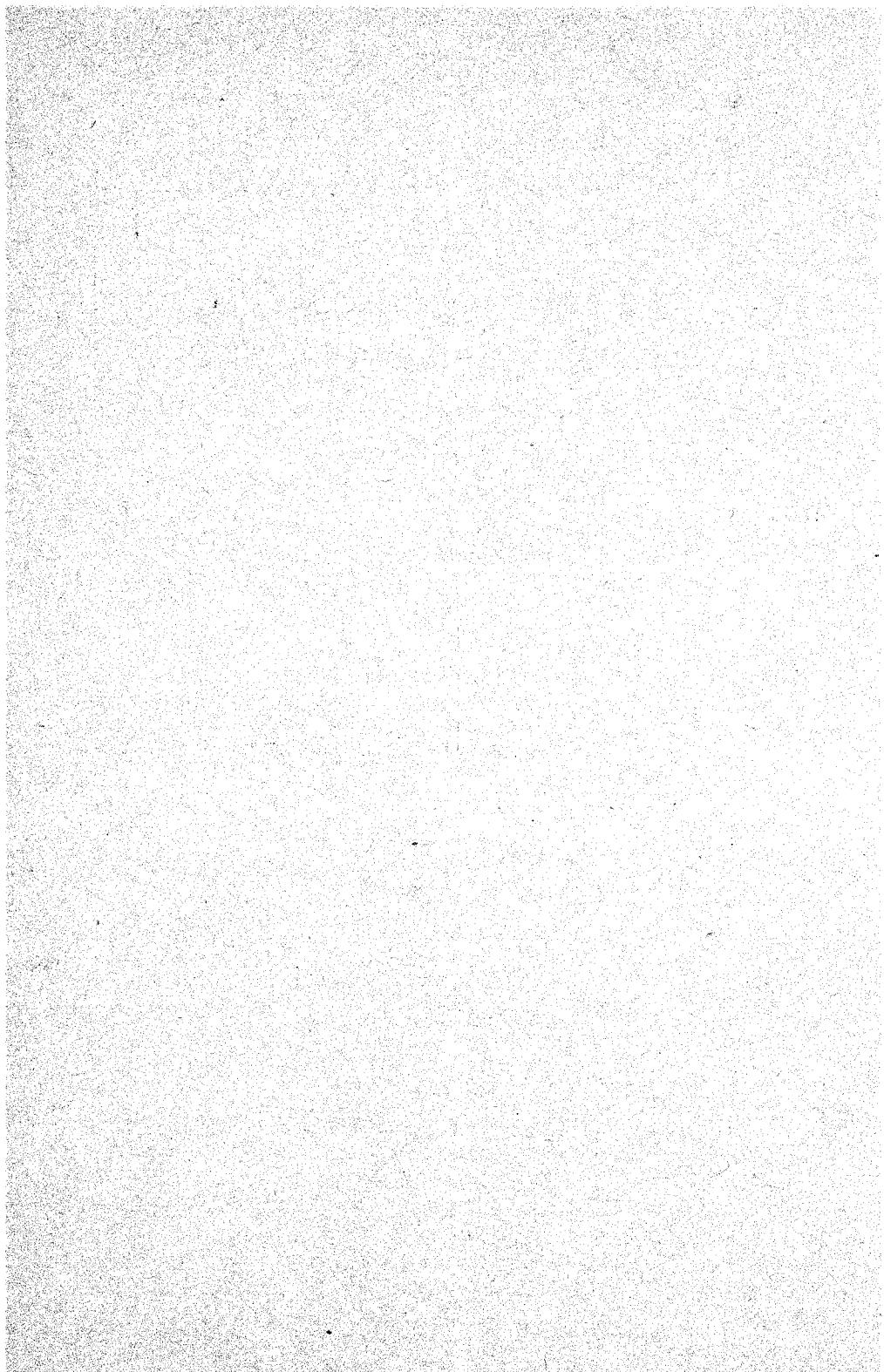


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**REPORT ON PRINCE ALBERT
HYDRO-ELECTRIC
DEVELOPMENT**

**THE
J. G. WHITE ENGINEERING
CORPORATION
NEW YORK**



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(COPY)
THE J. G. WHITE ENGINEERING CORPORATION,
NEW YORK.

New York, January 30th, 1914.

TO THE HONOURABLE, THE JOINT COMMITTEE OF THE
COUNCIL AND CITIZENS OF PRINCE ALBERT, PRINCE
ALBERT, SASKATCHEWAN.

GENTLEMEN:

Report on Prince Albert Hydro-Electric Development

1. GENERAL

As arranged with Mr. H. E. M. Kensit, City Commissioner, we submit the following report on the La Colle Falls Power Development on the North Saskatchewan River, now partially completed, and on other allied matters.

Our instructions as to the scope of the report are contained in a letter of November 27th, 1913, from Mr. Kensit, in which among other things it is stated that engineering, plans and quality of construction are not in question.

The works were visited by our representative during the period from December 14th to December 20th last, and data was collected as to cost of construction already done, flow of river, population, present consumption of electric current and other similar matters. We are considerably handicapped in our examination of the power plant by the lack of a complete set of plans, and also because no one familiar with the work was at hand with whom to discuss them, but during the last two days of stay in Prince Albert, valuable assistance was obtained from Mr. F. A. Creighton, formerly General Manager of Construction.

A conference was had at Toronto on December 24th with Messrs. C. H. and P. H. Mitchell, the engineers of the work, also with Mr. Flanagan, the resident engineer, and it was arranged with them to furnish quantities of work done and to be done, and also other data. As far as possible with the information at hand these quantities have been checked by us, and are believed to be correct.

On January 5th, 1914, Mr. G. R. Heckle, manager of the Ambursen Hydraulic Construction Company, was interviewed in Montreal, and information obtained from him as to proposed ways and means for completing the work, as well as other data. Our investigations have been seriously handicapped and delayed by having to obtain information from many sources located long distances apart.

2. DESCRIPTION OF HYDRO-ELECTRIC DEVELOPMENT AND AVAILABLE POWER

The hydro-electric development is located on the North Branch of the Saskatchewan River, about 26 miles below the city of Prince Albert at La Colle Falls, these being a series of rapids extending along the river for three or four miles, and having a total fall of about thirty feet. The diversion dam is located near the lower end

of the rapids, the tail race entering the river below the rapids. The available head utilized at the power house is about twenty-eight feet, 22 feet of which is due to the dam and about six feet to the fall in the river between the dam and the mouth of the tail race.

DESCRIPTION OF HYDRO-ELECTRIC PLANT

The plant as laid out consists of a diversion dam, at the south end of which is a lock for navigation purposes. At the north end of the dam is the intake structure. This controls the entrance of water to the canal, which is located along the northerly side of the river, and generally about 800 feet away from it. The power house is located on the canal about 2,000 feet below the intake, and is connected again to the river by a tail race about 1,650 feet long.

The dam is a hollow concrete structure of the Ambursen type, having a length of spill way of 755 feet, and is about 30 feet high above the bottom of its foundation, raising the water in the river about 20 feet. Provision is made for raising the water an additional two feet by flashboards. The total base width of the dam is 119 feet, of which about 66 feet is a concrete apron below the dam. The dam is divided into 50 bays, each having a usual length of 15 feet from the centre to centre of buttress. Six 8' x 12' stony sluice gates are to be placed in alternate bays at the bottom of the dam at its northerly end. The dam is founded on a very hard clay in which are buried occasionally small boulders.

The lock is a massive concrete structure designed for a lift of 23 feet at working water level. The lock chamber has an available length of 135 feet, and is 40 feet wide. The total length to the ends of the shore retaining walls is 506 feet.

The intake structure is of reinforced concrete 179 feet long, flanked at each end by extensive retaining walls. Provision is made for eight openings, each 18 feet wide, which are to be controlled by stop logs. Suitable racks are provided for and a reinforced concrete hood is to be constructed across the openings so that the water will enter 5½ feet below the normal water surface.

The canal is about 2,000 feet long, with a base width of 58 feet and side slopes of two horizontal to 1 vertical. The capacity of the canal, with water 15 feet deep and a slope of 1 foot in 2,000 feet as proposed, will be about 8,300 c.f.s., when free from ice, and about 4,500 c.f.s. when covered with three feet of ice. The slope in the canal when carrying sufficient water (about 2,000 c.f.s.) for the initial installation, will be about three inches in its length of 2,000 feet, and the velocity of flow about 1.5 feet per second. The canal generally will be constructed through a silty material which will erode very readily, but which will not permit much, if any, loss of water from filtration. It is not believed that any lining is necessary to prevent loss of water, but the maintenance may be considerable until the slopes adjust themselves.

The power house is designed to accommodate three turbine units of 2,500 horsepower, with the necessary generators, exciters, transformers, switchboards, etc. The building will be of concrete construction and only two turbines will be installed in the initial installation.

The tail race is about 1650 feet long with a base width of 46 feet, and side slopes of two horizontal to one vertical for a depth of 15 feet, above which the slopes are 1½ horizontal to one vertical. The tail race as laid out has sufficient capacity to carry the 2,000

c.f.s. required for the initial installation of 5,000 horsepower when free from ice, but unless the channel erodes, some head will be lost when it is covered with ice.

In the initial installation it is proposed to install two turbines of the vertical type of 2,500 horsepower each. At 80 per cent. efficiency and with 28 feet of head about 2,000 c.f.s. of water will be required to operate these turbines. Allowing for losses at generator, step-up and step-down transformers and for transmission, about 4,000 E.H.P. (24 hour power) will be available at the Prince Albert sub-station when there is sufficient flow in the river.

FLOW IN NORTH BRANCH OF THE SASKATCHEWAN RIVER AND AVAILABLE POWER

No records of the flow of the river at Prince Albert have to our knowledge been kept prior to October 1st, 1911, but since that time there have been records kept. During the time records have been kept no very large floods have occurred, the largest recorded being on July 14th, 1912, when the flow was 69,880 second feet. During 1913 the largest flow of which we have record occurred on April 24th, and was 32,450 c.f.s.

The largest known flood on the North Saskatchewan River occurred in August, 1899, and was 182,600 c.f.s. as measured at Edmonton, which is nearly 500 miles above Prince Albert. Whether this flood was larger or smaller at Prince Albert is not known, as no measurements were made, but several large tributaries enter between the two places.

The lowest flows appear to occur in the three winter months of January, February and March, when the records of 1912 and 1913 indicate that the flow will be about 1,500 cubic feet per second, the lowest flow of which we have record being 1,370 cubic feet per second on January 31, 1913. The mean monthly flows of December, 1911 and 1912, were about 2,300 second feet, and the minimum flows in the following January were 1,460 second feet in 1912, and 1,370 second feet in 1913. In 1913 the mean monthly flow for December was about 1,670 second feet. This would indicate that a low flow in January, 1914, of 1,000 second feet or less would occur.

Summarizing, it appears that ordinarily for the months of January, February, March and possibly half of April not over 1,500 c.f.s., or 3,000 E.H.P. delivered at the city sub-station can be depended upon, and that in low water years these figures may be reduced to 1,000 c.f.s., or 2,000 E.H.P.

3. EXISTING CONSTRUCTION CONTRACTS AND COST TO PLACE IN OPERATION THE COMPLETE DEVELOPMENT

The construction work is being carried out largely by the Amburseen Hydraulic Construction Company and by Walker & Company, Ltd., a subsidiary of the former company, the work being paid for on a cost plus fixed fee and fixed plant rental basis.

CONTRACT OF AMBURSEN HYDRAULIC CONSTRUCTION COMPANY

The contract with this company was signed April 24th, 1912, and provided that the company should build the navigation lock, the hollow concrete dam of the Amburseen type, the intake works

and a short piece of the canal, for which services the city is to pay the company a fee of \$62,000 and a further sum of \$20,000 for plant rental. Up to January 1st, 1914, the city had paid \$51,000 of the fee and \$17,000 of the plant rental charge. Active work, providing plant, men and material and construction camp, was started as soon as the contract was signed, and the excavation was started for the lock. For about three months, from the middle of June to the middle of September, 1912, the work was not pushed owing to possible changes in plans. The following tabulation shows interesting stages in the progress of the work

Pile driving for coffer dam began September 1, 1912.
 Cofferdam completed except to fill, October 25, 1912.
 Pumping cofferdam began November 7, 1912.
 Cofferdam flooded December 12, 1912.
 Pumping cofferdam resumed January 18, 1913.
 Excavation for lock resumed January 24, 1913.
 Excavation for gravel for concrete began January 24, 1913.
 First concrete (57 C.Y.) placed in lock February 24, 1913.
 Concrete (566 C.Y.) placed in lock to date, March 8, 1913.
 First concrete (127 C.Y.) placed in dam April 8, 1913.
 Cofferdam flooded due to high water, April 22, 1913.
 Concrete work resumed in dam, May 9, 1913.
 Cofferdam removed June 18, 1913.

On July 29th, 1913, at a time when the work was well organized and rapid progress being made on the contract, orders were given to close down owing to lack of funds, and on August 29th, 1913, work was practically entirely suspended. This suspension was very unfortunate and will materially increase the cost. Had the work continued, it is probable that the dam could have been completed across the river during the present winter, as the water in the river was at an unusually low stage during the summer and fall of 1913.

When work was suspended on August 29th, 1913, the following had been accomplished on the contract:

Lock: Concrete work practically completed, except near the tops of the walls.

Dam: South 293 feet (19 bays) completed out of a total length of 755 feet (50 bays).

Intake: Concrete foundations, 75 per cent. completed.

The principal quantities in cubic yards are as follows:—

EXCAVATION			CONCRETE MASONARY		
COMPLETED AUG. 30 '13	TO BE DONE	TOTAL	COMPLETED AUG. 30 '13	TO BE DONE	TOTAL
Lock	17,910	1,200	19,110	11,835	1,715
Dam	12,449	15,813	28,262	6,406	13,443
Intake Works	17,943	35,616	53,559	653	5,836
	48,302	52,629	100,931	18,894	20,994
					39,888

TIME AND METHOD OF CLOSING DAM

The flood period in the North Saskatchewan River extends from about the middle of April to about October 1, and appears to be divided into two parts: The flood from the nearby country, which occurs in the latter part of April when the ice goes out, and a

flow of from 30,000 to 40,000 second feet may be expected; and the much larger flood from the mountains, which occurs between the middle of June and the first of October, when floods of 70,000 second feet or over can be expected. Between May 1 and the middle of June there is a period of moderately high water, when not over 20,000 second feet need be expected.

The low water period appears to occur between October 1 and the middle of April, when the flow in the river probably does not exceed 10,000 or 15,000 second feet, and during the winter months is probably not over 1,500 or 2,500 second feet. It is during this period that most of the work of finishing the dam must be done, unless excessively costly cofferdams are to be constructed, and our estimates of cost to complete are based on doing the work during these months, when temperatures as low as 50 degrees below zero are certain to occur.

To care for the flow of the river through the completed part of the dam 19 temporary sluices have been provided for, one through each of the completed bays. These sluices at their entrance are 10 feet wide by 10 feet high, their bottoms being at elevation 1392. When the dam is completed, the openings will be filled with stop logs and the concrete masonry at the openings completed. With the cofferdam for closing built, and the river at elevation 1410, the 19 sluices will probably pass about 25,000 second feet of water unless obstructed with ice or otherwise. Before building the cofferdam across the river, the uncompleted work on the lock, estimated to cost \$21,355, and the intake works, estimated to cost complete \$94,594, should be practically finished. It should also be possible to build the north abutment and several nearby bays of the dam before building the cofferdam across the river.

It is not believed that any work can be done on the cofferdam closing the river until after the April floods carrying out the ice have passed, and probably the cofferdam cannot be closed before October 1.

ESTIMATED COST OF COMPLETING CONTRACT

	Expended to Aug. 30, 1913	Cost to Complete	Total Est. Cost when Completed
Dam and Spillway . . .	\$149,795	\$287,139	\$436,934
Lock	136,229	21,355	157,584
Canal Intake	15,781	94,594	110,375
Actual Construction	\$301,805	\$403,088	\$704,893
Supt'ce and Engin'g	\$ 11,338	\$ 8,140	\$ 19,478
General	70,735	15,659	86,394
Plant and tools	69,198	19,000	88,198
Miscellaneous	6,600	9,204	15,804
Contractors' fee	48,290	13,710	62,000
Plant rental	16,097	3,903	20,000
Material on hand	72,609	72,609	
	\$596,672	\$400,095	\$996,767
Contingencies 10 per cent		40,010	40,010
Total		\$440,105	\$1,036,777

It will be noticed in the above that the construction work actually done on August 30, 1913, on the dam and spillway, lock

and canal intake, cost \$301,805, while the work to be done to complete the same structures is estimated to cost \$403,088, and this includes the hazardous work of closing the dam across the river.

CONTRACT OF WALKER & CO., LTD.

The contract with this Company was signed on May 1, 1913, and provided that the Company should construct the power house and excavate the tail race, for which services the City is to pay the Company a fee of \$30,000, and a further sum of \$10,000 for plant rental. Up to January 1, 1914, the City had paid \$10,000 of the fee, and \$4,000 of the plant rental charge.

Considerable excavation had been done on the work covered by this contract by the Ambursten Hydraulic Construction Company in obtaining gravel for concrete previous to signing the contract with Walner and Company, which continued the work. At the present time about 40 per cent. of the tail race excavation has been completed, and about 60 per cent. of the excavation for the power house. No masonry has been built.

The principal quantities in cubic yards are as follows:—

	EXCAVATION		CONCRETE MASONARY	
	Completed to Aug. 30, 1913	To be Done	Completed Total	To be Aug. 30 '13 Done
Power house foundations				
including				
Wing walls .	6,692	4,308	11,000	0 6,140 6,140
P. H. super- structure . . .				0 915 915
Tail race . . .	77,498	115,791	193,229	
Canal	9,696	4,054	13,750	
Total	93,886	184,093	217,979	0 7,055 7,055

ESTIMATED COST OF COMPLETING CONTRACT

	Expended to Aug. 30, 1913	Cost To Complete	Total Est. Cost When Completed
Canal 17 80-19-67 . . .	\$ 5,663	\$ 2,432	\$ 8,095
Tail race	27,047	55,442	82,489
Power house foundations			
including wing walls	1,237	103,309	104,546
P. H. Superstructure .		28,274	28,274
Actual construction . .	33,947	189,457	223,404
General	2,268	16,273	18,541
Plant	7,677	12,290	19,867
Contractors' fees . . .	7,500	22,500	30,000
Plant rental	3,000	7,000	10,000
Material on hand	15,453	15,453	
	\$69,745	\$232,067	\$301,812
Contingencies 10 per cent.	.	23,207	23,207
Total cost		\$255,274	\$325,019

It will be noticed that the actual construction work on August 30, 1913, cost \$33,947, while the work to be done is estimated to cost \$189,457. None of the work to be done is hazardous.

CONTRACT OF PRINCE ALBERT TRANSFER COMPANY

This is a unit price contract for excavating 92,000 cubic yards of the canal, of which 49,729 cubic yards had been excavated on September 30, 1913, the price being 24 $\frac{3}{4}$ cents.

Expended to Jan. 1, 1914, 49,729 c.y. at 24 $\frac{3}{4}$ c \$12,307.93
Cost to complete 42,271 c. y. at 24 $\frac{3}{4}$ 10,462.07

	\$22,770.00
Add 5 per cent. for contingencies	1,138.50
Total	<u>\$23,908.50</u>

TRANSMISSION LINE

Our estimate provides for 28 miles of substantial wood pole line operating at 33,000 volts, and of 4,000 E.H.P. delivering capacity. The poles are to be 40 feet long, 35 to a mile, and the power wires for a single three-phase circuit are to be No. 1 stranded copper. A ground wire is provided for, and right-of-way is estimated at \$75 per mile. The estimated cost for 28 miles of transmission line at \$2,800 is \$78,400.

RECEIVING AND STEAM AUXILIARY STATION IN CITY

It is proposed to install three-1,000 K.W. three-phase water cooled transformers and 2-750 K.W. (2,000 E.H.P.) steam turbo-generator sets in a new building contiguous to the present power station. No additional boilers are provided for, as it is proposed to operate from the boilers (1,200 H.P.) at present installed, and provide an additional stack to permit of forcing above normal rating when necessary. Only part of the installation, it is assumed in our later consideration of operating results, will be made immediately, and it may not be necessary to complete the installation before 1918. The 2,000 E.H.P. provided for is the deficiency below 4,000 E.H.P. resulting from low water at the hydro-electric plant in the winter months, previously discussed. The estimated cost of the completed station is \$125,750.

SUMMARY OF ESTIMATES OF COST

Tenders have been received from the manufacturers for practically all of the equipment, and the prices used in our estimate of cost are based on these tenders, with sufficient added to cover transportation from Prince Albert to the power house and common labor for installing; also, for miscellaneous small equipment.

The following tabulation summarizes the construction costs to January 1, 1914, and the estimated cost of the work to be done

(10)

under the assumed construction plan to January 1, 1916. The further construction costs in subsequent years are shown later:

	EXPENDED TO JAN. 1, '14	COST TO COMPLETE TO JAN 16, '14	T	TOTAL COST JAN 1, '16
Ambursten Contract to Aug 30, 1913,	596,672	440,105	1,036,777	
due but not paid	7,933	7,933		
Walker Con't to Aug. 30, 1913	69,745	255,274	325,019	
Walker contract to since Aug. 30, 1913	14,201	14,201		
Prince Albert Transfer Co. contract ..	12,308	11,601	23,909	
Transport'ion by city boat	18,538	15,000	33,538	
Six Stoney Sluice Gates	524	12,476	13,000	
Lock gates and fittings	2,481	7,519	10,000	
Hydraulic equipment, 5,000 h.p.		45,000	45,000	
Electrical equipment, two generators				
1875 k.v.a		45,000	45,000	
Electrical equipment, switching		15,000	15,000	
Electrical equipment, transformers ..		10,000	10,000	
Electrical equipment, regulators		2,500	2,500	
Crane (20-ton hand)		5,000	5,000	
Transmission line, 28 miles		78,400	78,400	
Telephone line	8,562		8,562	
Receiving and steam Auxiliary station		83,600	83,600	
Distribution system additions		28,000	28,000	
Operative quarters at power plant ..		10,000	10,000	
Preliminary borings and miscellaneous	26,386		26,386	
Purchase of land	3,654	4,000	7,654	
Engin'g, C.H. and P.H. Mitchell	21,250	22,750	44,000	
Engineering camp expenses	9,388	5,000	14,388	
Engineering, consulting engineers	5,829	5,000	10,829	
General Manager	5,234	6,000	11,234	
Miscellaneous small bills	2,029		2,029	
Testing and starting		5,000	5,000	
Contingencies other than on the Ambursten, Walker and Prince Albert Transfer Co. contracts		30,000	30,000	
Total construction cost	\$788,868	\$1,135,957	\$1,924,825	

FIXED CHARGES ON COMPLETE COST:

On January 1, 1913, debentures were issued for \$500,000, bearing interest at 4 1/2 per cent, and maturing in 1953, and were sold in London in March, 1913, netting the City \$396,347. The interest on the debentures is payable from the proceeds of their sale for three years, or until the completion of the work, if this occurs sooner; and the by-law under which they are issued does not provide for any sinking fund for the first three years after their issue, but after this three years an annual sinking fund of \$6,120 must be paid.

The total amount of each expended or due on account of the hydro-electric plant on January 1, 1914, was as follows:

Construction cost (see previous tabulation)	\$788,868
Interest on debentures, paid July 1, 1913 ..	\$11,265.00
Interest on debentures due Jan. 1, 1914	11,265.00
Interest on Treasury Notes	16,974.00
	39,504
Total amount January 1, 1914	\$828,372

(11)

Assuming that the same terms will be obtained in financing that part of the \$828,372 not provided for in the original issue of \$500,000 of debentures, it will be necessary to issue about \$545,000 additional debentures, making a total issue of \$1,045,000 to provide for the payment of the amount expended and due to January 1, 1914.

Assuming that the hydro-electric plant will be in operation by January 1, 1916, and also assuming that the same terms will be obtained in financing the \$1,135,957 required to complete at that time as was obtained for the original issue of \$500,000 of debentures, the total amount of debentures will be as follows:

	Cash	Debentures
Construction cost to Jan 1, 1914.....	\$788,868	
Interest to Jan. 1, 1914	39,504	
	<hr/>	<hr/>
	\$828,372	\$1,045,000
Interest on \$1,045,000 Jan. 1, 1914 to Jan. 1, 1916, two years at 4 1/2 per cent.	94,050	.
Cost to complete from Jan. 1, 1914, to Jan. 1, 1916	1,135,957	
Interest on \$1,135,957 debenture for one year, 6 months	76,842	
Interest on \$540,000 debenture for 9 mos	18,225	
	<hr/>	<hr/>
Total	\$1,324,574	1,671,000
	<hr/>	<hr/>
Total construction cost only	\$1,924,825	\$2,716,000

In the above it is assumed two-thirds of the additional expense from January 1, 1914, is provided for by debentures bearing interest from July 1, 1914, and one-third by debentures interest bearing from April 1, 1915.

The yearly fixed charges on the completed work as of January 1, 1916, would then be:

Interest on \$2,716,000 at 4 1/2 per cent	\$122,220
Sinking fund on \$2,716,000 at 1.224 per cent.	33,243
	<hr/>
	\$155,463

The above figures provide only for one 750 K.W. steam turbo generator with condenser, switchboard, etc., and 2,000 K.W. of substation step-down transformer capacity installed in a new building adjoining the boiler room of the present steam plant. They, however, include the allowance shown for extensions to the local distribution system during the next two years.

About the middle of 1917, it is assumed a third transformer of 1,000 K.W. is installed in the substation, and a year later the second steam turbo-generator and accessories, including a new stack for the boilers. Allowances for distribution system additions and extensions are also made. The necessary amounts for each year are estimated as follows, together with corresponding debentures and additional interest and sinking fund charges:

(12)

Years Ending Dec. 31.	1917	1918	1919
Additional substation and steam			
Auxiliary equipment	\$ 4,760	\$37,390	
Additional to distribution system	14,700	14,300	8,800
	<hr/>	<hr/>	<hr/>
	\$19,460	\$51,690	\$8,800
Debentures	24,000	65,000	11,000
Interest, Sinking Fund, Charges on			
Debentures prior to Jan. 1, 1916	155,463	155,463	155,463
Interest on additional debentures ..	540	2,543	4,253
Sinking Fund additional debentures	147	692	1,157
	<hr/>	<hr/>	<hr/>
Total charges	156,150	\$158,698	\$160,873

Interest on additional debentures is figures on the assumption that they are outstanding for only six months of the year for which required, with full year's interest thereafter. Sinking fund charges are similarly figured at the rate of 1.224 per cent. as for the first \$500,000 of debentures.

We have estimated the annual depreciation independently on the hydro-electric development, transmission line, substation, steam auxiliary and distributing system. Such parts of the construction as the concrete in the dam, lock, headworks, power house sub-structure, and excavation, transmission line copper, etc., which are practically undepreciable, have not been considered. The proper annual depreciation was found to be as follows, the increase from 1916 to 1919 being due to increased investment from year to year:

1916	\$28,400
1917	29,400
1918	32,000
1919	32,400

The sinking fund charge of \$34,400 for 1919 shows a margin over the above for the same year. A sinking fund requirement is in the nature of a depreciation provision, for, while it is not applicable to renewals, it retires the original investment. We make no further deduction for renewals in the estimate of financial results shown later, although cash for this purpose will have to be provided from time to time in the future in some manner.

IV. MARKET FOR POWER

We have assumed a regular growth in population for the future at about the same average rate as during the past seven years. A corresponding growth in commercial and municipal lighting has been estimated upon, allowing for slightly greater per capita results; but this per capita increase has been taken as very slight because of the present relatively high per capita figure, and our opinion that the lighting field has been pretty well developed.

At present current for commercial power is metered, and is confined entirely to small users. The total connected load for this class of business on December 16, 1913, was 1,097 H.P., of which about 1,017 H.P. was in use, and consisted of various small alternating current motors ranging in size from about $\frac{1}{2}$ H.P. to 75 H.P. It appears that a considerable part of this load was not in operation during the entire year. A tabulation prepared by the City from a canvass shows prospective business of this class existing

to the extent of about 860 H.P., and we have assumed that all this will be secured during the next two years, and one half in 1914 and the other half in 1915. Because of the growth of the City it seemed reasonable to assume that this small commercial business would continue to develop in subsequent years, although probably at a somewhat diminishing rate as the point of saturation is approached.

Upon the completion of the hydro-electric development and with 4,000 H.P. available at the Prince Albert substation, there will be an excess over the requirements for lighting and miscellaneous small commercial power available for sale in larger blocks to factories and industries which may be induced to establish themselves in the City. This excess may be classified as follows:—

First class power—Continuous, 24 hours daily.

Second class power—continuous throughout the year, except during the period of daily peak load, in the low water winter months.

Upon our assumption that hydro-electric power will be available by January 1, 1916, and upon the further assumption that an energetic campaign succeeds in inducing factories to locate in the City, we are estimating that by the end of 1918 the entire surplus over lighting and small commercial power requirements will be disposed of up to 4,000 E.H.P. at sub-station bus bars.

It probably would be found difficult to induce the location of factories prior to the actual completion of the hydro-electric development, that is by January 1, 1916, and it has been assumed that during 1916 none of this factory power can be disposed of, but that during 1917 half of the amount available will be contracted for and the balance during 1918. To be conservative we have allowed during the year in which the power is contracted for only six months' full earnings, the full twelve months' earnings from such contracts being only secured in the following year, with the result that 1919 will be the first year when the real earning capacity of the 4,000 electrical H.P. appears.

Attached hereto is a hypothetical load curve for December, 1918, based on the preceding assumptions, and this shows at the top a block of power available for 24-hour use. At the peak period in the evening is also indicated the extent to which the steam auxiliary will be required, both for a year of low water (1,000 second feet daily flow), and for an ordinary year (1,500 second feet daily flow).

This curve sheet shows that about 500 H.P. of second class or "off peak" power might also be sold. This is equivalent to about 400 H.P. delivered to the customer.

It is also evident that, if the first class and second class factory power were used only for 10 or 12 hours during the day, there would be considerable power available during the late night and early morning hours, but it is questionable whether any market for this could be developed, and we have disregarded it in our calculations.

A tabulation showing the power situation as disclosed by the records up to the end of 1913, and as estimated by us for the future, follows:

(14)

End of Year	Yearly load Factor	Metered Load on Sub-stations (K.W.)		Additional Average.		Max. Factory Power at S. S.	Metered K. W. H.	Lighting and Power Sold K. W. H.	Total Factory Power Sold, Basis H. P. Contracts			
		Yearly Max.	H.P.	Yearly Max.	K.W.				L'tg.	Pr.	Total	1st Class
1909	17.3	34	197			224,180		2,468			226,648	
1910	19.1	50	262			306,367		31,409			337,776	
1911	20.3	67	330			421,958		39,924			461,882	
1912	17.5	110	630			694,407		103,225			797,632	
1913	29.3	205	700			1,101,018		356,000			1,457,018	
1914	30.0	241	800			1,257,000		536,000			1,793,000	
1915	31.0	282	910			1,425,000		716,000			2,141,000	
1916	33 1-3	322	966			1,580,000		896,000			2,476,000	
1917	35	362	1,035	1,250	940	1,750,000	1,066,000	2,816,000			1,100	
1918	36	404	1,120	2,500	1,880	1,910,000	1,216,000	3,126,000			2,200	400
1919	37.5	465	1,240	2,500	1,880	2,090,000	1,336,000	3,426,000	2,200		2,200	400

V. RATES

The existing rates charged in Prince Albert for metered commercial lighting and power have been in existence with some minor changes for the last two years, and at present are about the same as those in force in other cities in Western Canada. A comparison with other cities is shown in the following tabulation on the next page:--

LIGHTING RATES		
	Commercial	Municipal
Prince Albert, Sask.	8c per k.w.h. Discount: 5 p.c.-15 p.c.-10 da. Min. chg. mo: Residence, 50c. Business, \$1.	6.6. amp. magnetite arcs, at \$100 yr. Westingh A.C. arcs at \$81 yr.
Saskatoon, Sask.	To 151 k.w.h., 9c-7c. Discount: 10 p.c.-10 da.	Arches at \$70 ea. per sea- son. Tungstens at com- mercial light rates.
Regina, Sask.	To 300 k.w.h., 7c-6c. Discount: 10 p.c.-10 da. Min. chg. mo., \$1.	
Edmonton, Alta.	To 2,200 k.w.h., 8c-6c. Discount: 5 p.c.-10 da. Min. chg. mo., 75c.	
Calgary, Alta.	To 1500 k.w.h. 7 1/2 c-4c. Discount: 10 p.c.-10 da. Min. Chg. Mo. \$1 net.	6.6. amp. magnetite arcs at \$65 yr. 6.6. amp, A.C. enclosed arcs at \$60 yr. 250 watt series tungstens at \$25 yr.
Lethbridge, Alta.	To 300 k.w.h. 10c-8c. Factory: 6c. Discount: 20 p.c.-10 da.	
Winnipeg, Man. (El. Ry. Co.)	Residences, 3 1/2 c. Busi- ness, 3 1-3c. Discount: 10 p.c.-35 p.c.	
Helena, Mont.		
Port Arthur, Ont.	Residence; 4c per 100 sq. ft.-2 1/2 k.w.h. Business, 6c k.w.h. \$1.35 30 hrs. 2 1/2 c k.w.h. for add'l con- sumption. Discount: 10 p.c. prompt. Mih. chg. mo. Residence, 25c. Business, 50c.	

POWER RATES		Special Rates
Metered	H.P. Year Basis	
To 2,000 k.w.h., 6c-3 1/2 c. 2,001 and above, 3c-2c. Min. chg. mo., \$1 per h.p. to 10 h.p. Over 10 h.p. special.		
6c k.w.h. Over 100 h.p. installed capacity, 3c net. Discount: 5 p.c.-30 p.c. Min. chg. mo., \$2		Municipal pwr., 2c k.w.h.
Consumers taking 100 h.p. min., 1.1c k.w.h. on 24 hr. load and \$1.25 k.w.h. on 10 hr. load. Discount 10 p.c.-10 da. Min. chg. mo., \$1 per h.p.		Day time light used on 2- rate meter, over 5 k.w. max demand, 5c k.w.h.
To 1,200 k.w.h., 8c-3 1/2 c. Heat: 5c k.w.h.. Discount: 10 p.c.-10 da. Add'l 10 p.c. for over 10,000 k.w.h.		Meter rent: lgt. 25c mo.; power, 50c mo.
To 25,000 k.w.h. 2c-1.1c. To 2 h.p. at off peak 3c k.w.h. Discount: 10 p.c.- 10 da. Min. chg. mo. To 20 h.p. \$1 per h.p. Add'l h.p. at 50c.	Pwr. purchased whole- sale at \$29 h.p. yr. and retailed on sliding scale.	Pwr. ho. lgt., 3.4c k.w.h. (internal chg). Munic. pwr., 2c (internal chg.)
To 3,000 k.w.h. 6c-2c. Discount: 10 p.c.-10 da.	Factory rates: Over 100 h.p. to 39 operatives, \$16- \$12 h.p.	Flat lgt. rates: 1 lt., 16 c.p.-75c and each add'l to 4 lt. 16 c.p.-50c.
3c-1/2 c (Note: Rates of W. El. Ry. Co. in compe- tition with municipal water power).	Power purchased 250 h.p. min. to 1,000 h.p. max. av. 500 h.p. \$25 peh h.p. yr. max. basis. Over 500 h.p. av.: Each 50 h.p. add'l block at \$2,500 yr. (allowing 100 h.p. max. per block).	
	24 hr. pwr. based on peak, \$25. Restricted power based on peak, \$20.	

LIGHTING RATES		
	Commercial	Municipal
Fort William, Ont.	5c k.w.h.	
Moose Jaw, Sask.	8c k.w.h.. Discount: 10 p.c.-10 da. Min. chg mo. \$1.	

If the existing rates are maintained in the future it is probable that the average rate received per K.W.H. will gradually decrease, because of the increasing small commercial power load.

Such information as was obtainable has been shown in the preceding tabulation regarding power contracted for on a H.P.-year basis, and from a consideration of these figures, and from the further fact that the City wishes to offer low rates for power to induce the location of factories, we have adopted the following assumptions regarding rates per H.P. on a yearly contract basis, which will make the undertaking about break even:

First class continuous power, \$30 per H.P. per year, ordinary maximum demand.

Second class power, \$20 per H.P. per year, ordinary maximum demand.

POWER RATES		Special Rates
Metered	H.P. Year Basis	Special Rates
To 5 h.p. 4; k.w.h.	\$25 h.p. yr.	<p>Base rates: To 101, 3½c-1¼c k.w.h. plus fixed chgs. per installed h.p. per mo., \$1.25 to \$1.</p> <p>24 hrs. unrestricted, 100 p.c. base rate.</p> <p>24 hrs. restricted, 90 p.c. base rate.</p> <p>10 hrs. unrestricted, 90 p.c. base rate.</p> <p>10 hrs. restricted, 66.6 p.c. base rate.</p> <p>Discount 10 p.c.-10 da.</p> <p>Meter rent at 25c mo. for lighting. All classes of domestic use, incl. light for use during entire year, 5½c k.w.h. Discount: 10 p.c.-10 da. Min. chg. mo., \$5.00 m.o.</p> <p>Industrial concerns regularly operating at least 5 hrs. per night, light at power rates.</p>

VI. ESTIMATED RESULTS OF OPERATION

The following tabulation shows past results, the 1913 figures being estimated for the month of December, and also our estimates for the future based on the assumptions previously discussed. In arriving at steam auxiliary operating expenses it has been assumed that factory power would be required not over 12 hours per day. Also these expenses are based on the hydro-electric power deficiency in an ordinary year. In a low water year the steam auxiliary expense would be about \$26,000 greater than we show for 1919 conditions:

The developed business of the present electric light property is included in our figures, and consequently the fixed charges on the investment represented should not be lost sight of. These amounted, we are informed, in 1913 to \$11,175 for interest, and \$6,069 for sinking fund, or a total of \$17,244, but we have not included this in the fixed charges shown in the following:

(20)

ACTUAL AND ESTIMATED RESULTS OF OPERATION.
STEAM PLANT ONLY

	1909			1910		
	Per K. W. H.	Gen.	Sold	Per K. W. H.	Gen.	Sold
Gross Earnings						
Lighting	24,998.70	.0843	.1115	30,634.04	.0709	.100
Power:Gen.Met'd(basis kwh	293.93	.0009	.1190	2,871.47	.0067	.0913
Meter Rent	1,347.31	.0045		1,602.55	.0037	
Miscellaneous Receipts	71.76	.0002		193.72	.0004	
Total revenue	26,711.70	.0899		35,301.78	.0817	
Discounts	1,778.12	.0059		2,713.19	.0063	
Net Gross	24,923.58	.0840	.1109	32,588.59	.0754	.0965
Operating Expenses						
Exist'g Stm. or El. Sub. Sta Generating						
Fuel	9,125.82	.0307		9,846.07	.0228	
Labor	3,598.13	.0121		4,420.20	.0103	
Maintenance	758.81	.0026		921.31	.0021	
Total Generating	13,482.76	.0454		15,187.58	.0352	
Distribution	1,705.69	.0057		1,808.86	.0041	
Gen.(Off.exp., Sal. and Inc.	671.41	.022		858.01	.0020	
Total Operation Expenses ..	15,859.86	.0533		17,854.45	.0413	
Operating Rates	63.4 p.c.			54.8 p.c.		
Net Earnings	9,073.72			14,734.14		
Deductions						
Sinking Fund	2,067.47			2,613.80		
Debenture Interest	4,474.87			4,556.84		
Depreciation on Tools						
Total deductions	6,542.34			7,170.64		
Surplus	\$2,531.38			\$7,563.50		
Commercial l'ghting, m't'red (sold) K.W.H..						
Municipal requirements, K. W. H.	\$186.930			226,367		
TATISTICS—				80,000		
Total K.W.H. sold Co., I't'g and municipal ..	224.180			306,367		
Commercial power metered (sold) K.W.H... .	2,468			31,409		
Power house and pump house l't'g, K.W.H..	24.750			29,700		
Total K.W.H. accounted for	251.410			367,475		
Total K.W.H. generated in Prince Albert Sta.	296,900			432,000		
Peak load, Prince Albert station. K.W.	197			262		
Load factor (year 24 hour basis) per cent.	17.2			18.8 p.c.		
Population	5,500			6,600		

(21)

**ACTUAL AND ESTIMATED RESULTS OF OPERATION
STEAM PLANT ONLY**

1911			1912			1913		
Per K. W. H.			Per K. W. H.			Per K. W. H.		
Amount	Gen.	Sold	Amount	Gen.	Sold.	Amount	Gen.	Sold.
\$	\$	\$	\$	\$	\$	\$	\$	\$
39,399.22	.0674	.0934	52,435.21	.0546	.0755	70,371.50	.0393	.0638
3,606.52	.0062	.0902	4,370.61	.0045	.0423	12,245.00	.0068	.0344
2,044.00	.0035		2,845.65	.0030				
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45,049.74	.0771		59,651.47	.0621		82,616.50	.0461	
2,666.00	.0046		4,376.30	.0046		4,500.00	.0025	
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42,383.74	.0725	.0916	55,275.17	.0575	.0692	78,116.50	.0436	.0536
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13,204.82	.0226		16,846.38	.0175		20,280.00	.0113	
5,121.20	.0088		6,022.85	.0063		7,500.00	.0042	
1,500.13	.0026		4,870.13	.0051		6,000.00	.0033	
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19,826.15	.0340		27,739.36	.0289		33,780.00	.0188	
2,782.72	.0047		5,041.14	.0052		6,000.00	.0034	
1,129.81	.0019		2,437.50	.0025		5,500.00	.0031	
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23,738.68	.0406		35,218.00	.0366		45,280	.0253	
56.1p.c.			63.7 p.c.			57.8p.c.		
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18,645.06			20,057.27			32,836.50		
<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
2,567.89			3,393.62					
5,077.56			6,789.56					
			431.86					
<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
7,645.45			10,615.04					
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10,999.61			9,442.23					
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338,358			567,791			830,980		
83,600			126,616			270,038		
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421,958			694,407			1,101,018		
39,924			103,225			356,000		
35,650			39,600			30,820		
497,532			842,232			1,724,985		
585,000			960,775			1,790,493		
320			620			700		
20.8p.c.			17.4p.c.			29.3p.c.		
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8,000			10,000			12,000		

Continued.—ACTUAL AND ESTIMATED RESULTS OF OPERATION.
STEAM PLANT ONLY

	1914			1915		
	Per K. W. H.			Per K. W. H.		
	Amount	Gen.	Sold.	Amount	Gen.	Sold.
Gross Earnings						
Lighting	\$ 78,600.00	.0366	.0625	\$ 85,500	.0334	.0060
Power:Gen.Met'd(basis kwh	18,300.00	.0085	.0341	24,500	.0096	.0319
Meter Rent						
Miscellaneous Receipts						
Total revenue	96,900.00	.0429	.0513	110,000	.0430	
Discounts	4,800.00	.0022		5,500	.0021	
Net Gross	92,100.00	.0429	.0513	104,500	.0409	.0487
Operating Expenses						
Exist'g Stm. or El. Sub. Sta Generating						
Fuel	35,800.00	.0166		42,600	.0166	
Labor	7,500.00	.0035		7,500	.0029	
Maintenance	6,300.00	.0029		7,400	.0029	
Total Generating	49,600.00	.0230		57,500	.0224	
Distribution	6,500.00	.0030		6,800	.0027	
Gen.(Off.exp., Sal. and Inc.	5,500.00	.0026		5,500	.0021	
Total Operation Expenses ..	61,600.00	.0286		69,800	.0272	
Operating Rates	66.9 p.c.			66.5 p.c.		
Net Earnings	30,500.00			34,700		
Deductions						
Sinking Fund						
Debenture Interest						
Depreciation on Tools						
Total deductions						
Surplus						
Commercial l'ghting, m't'red (sold) K.W.H..						
Municipal requirements, K. W. H.						
TATISTICS—						
Total K.W.H. sold Co., l't'g and municipal ..	1,257,000			1,425,000		
Commercial power metered (sold) K.W.H... .	536,000			716,000		
Power house and pump house l't'g, K.W.H..	40,000			40,000		
Total K.W.H. accounted for	1,833,000			2,181,000		
Total K.W.H. generated in Prince Albert Sta.	2,150,000			2,560,000		
Peak load. Prince Albert station. K.W.	800			910		
Load factor (year 24 hour basis) per cent.	30.0 p.c.			31.0 p.c.		
Population	13,100			14,250		

(23)

**ESTIMATED RESULTS OF OPERATION HYDRO-ELECTRIC PLANT WITH
STEAM PLANT AS AUXILIARY**

	1916			1917		
	Per K.W.H.			Per K.W.H.		
Gross Earnings	Amount	Gen.	Sold	Amount	Gen.	Sold
Lighting	\$92,400	\$.0313	\$.0585	\$99,500	\$.0568	
Power	28,600	.0097	.0319	32,000	.030	
General, metered (basis k.w.h.)						
Factory (Basis h.p. Year)						
First Class						
Second Class						
 Total Revenue	121,000	.0410		148,000		
Discounts	6,000	.0020		6,600		
 Net Gross	115,000	.0390	.0464	141,400		
 Operating Expenses						
Hydro-Electric Plant						
Labor and Materials	8,300	.0028		8,300		
Maintenance	2,000	.0007		2,000		
 Total Hydro-Electric Plant	10,300	.0035		10,300		
Existing Steam or New El.						
Sub. station						
Generating						
Fuel						
Labor	3,300	.0011		3,300		
Maintenance	p.c. 500	.0002		500		
 Total Generating	3,800	.0013		3,800		
Transmission	1,900	.0006		1,900		
Distribution	7,200	.0024		7,600		
General (Sal. Off Expenses and Inc.)	5,500	.0019		5,500		
 Total Operating expenses	28,700	.0097		29,100		
 OPERATING RATIO	24.9 p.c.			20.5 p.c.		
 Net Earnings						
Deductions—	86,300			112,300		
Sinking Fund						
Debenture Interest						
Total Deductions	155,463			156,150		
 Surplus	69,163			43,850		
 STATISTICS—						
Total K.W.H. Sold. Com. Litg. and Municipal	\$1,580,000			1,750,000		
Commercial Power Metered (sold) K.W.H.	896,000			1,066,000		
Power House and pump house Lgt. K.W.H.	40,000			50,000		
Total K.W.H. accounted for	2,516,000			2,866,000**		
Total K.W.H. generated in Prince Albert Sts.	2,950,000			3,360,000**		
Peak load, Prince Albert station, K.W.	966			1,975		
Load factor, (Year, 24 hour basis) per cent.	33 1-3			35.0 p.c.		
Population	15,400			16,600		

NOTE—*Per H.P. per year ordinary maximum

**Does not include factory power

(24)

**ESTIMATED RESULTS OF OPERATION HYDRO-ELECTRIC PLANT
WITH STEAM PLANT AS AUXILIARY**

Gross Earnings	1918		1919		
	Amount	Per K.W.H.	Amount	Per K.W.H.	
Lighting	\$106,500	.0558	\$113,000	.054	
Power	36,500	.030	40,000	.030	
General, metered (basis k.w.h.)					
Factory (Basis h.p. Year)					
First Class	49,500	30.00	*	66,000	30.00*
Second Class	4,000	20.00	*	8,000	20.00*
 Total Revenue	\$196,500		227,000		
Discounts	7,200		7,600		
 Net Gross	\$189,300		219,400		
 Operating Expenses					
Hydro-Electric Plant					
Labor and Materials	8,300		8,300		
Maintenance	2,500		2,500		
 Total Hydro-Electric Plant	10,800		10,800		
Existing Steam or New El. Sub. station					
Generating					
Fuel	5,500		11,000		
Labor	4,300		4,300		
Maintenance	3,500		3,500		
 Total Generating	13,300		18,800		
Transmission	1,900		1,900		
Distribution	8,000		8,500		
General (Sal. Off Expenses and Inc.)	5,500		5,500		
 Total Operating expenses	39,500		45,500		
 OPERATING RATIO	20.8 p.c.		20.7 p.c.		
 Net Earnings	149,800		173,900		
Deductions—					
Sinking Fund	\$158,698		160,873		
Debenture Interest					
Total Deductions					
 Surplus	8,898		13,027		
 STATISTICS—					
Total K.W.H. Sold. Com. Ltg. and Municipal	\$ 1,910,000		2,090,000		
Commercial Power Metered (sold) K.W.H.	1,216,000		1,336,000		
Power House and pump house Lgt. K.W.H.	50,000		50,000		
Total K.W.H. accounted for	3,176,000**		3,476,000**		
Total K.W.H. generated in Prince Albert Sts.	3,730,000**		4,080,000**		
Peak load, Prince Albert station, K.W.	3,000		3,120		
Load factor, (Year, 24 hour basis) per cent.	36.0 p.c.		37.5 p.c.		
Population	17,750		18,850		

NOTE—*Per H.P. per year ordinary maximum

**Does not include factory power

For eight months of the year, from about April 15 to about December 15, probably 3,000 C.F.S. would be available. This will give about 6,000 E.H.P. at the Prince Albert substation, or an increase of 2,000 E.H.P. for eight months. Assuming that a third unit is installed in the power house, additional step-up and step-down equipment provided and the transmission line duplicated, the increased cost would be:

Hydraulic equipment	\$22,500
Electrical equipment, generator	22,500
Electrical equipment, switching	7,500
Electrical equipment, transformer	5,000
Transmission line	78,400
Substation equipment (No additional steam auxiliary)	9,000
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	\$144,900
Contingencies, etc., 15 per cent., say	21,700
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	\$166,600
Debentures necessary to cover above	\$210,000

If this power were sold practically no additional operating expense would be involved, but the additional charges would be.

Interest on \$210,000 at 4 1/2 per cent.	\$9,450
Sinking fund on \$210,000 at 1,224 per cent.	2,570
	<hr/>
	\$12,020

No doubt whether it would be possible to sell secondary power of this kind, the time it is available being so short, but if it can be, not more than \$12 per H.P. probably would be obtained. The results would then be:

Gross from 8 months' power, 2,000 h.p. x .875	
power sold, 1,750 h.p. x \$12	\$21,000
Fixed charges as above, say	12,000
	<hr/>
	\$9,000

VIII. ALTERNATIVE PLANS

If the construction of the hydro-electric plant is proceeded no further with, the alternative plans are presented of:

1. Building as a substitute a steam plant with a capacity of 4,000 electrical horse power, or
2. Adding to the present steam plant as general lighting and small power business increases and making no attempt to sell industrial power in large blocks at low rates.

Under plan No. 1, and making the same assumptions as to earnings as we have previously for the year 1919, the figures would be as follows:

Cost of new steam plant, 4,000 E.H.P. capacity including engineering, contractor's profit, and contingencies, etc.	\$291,000
Extending of distribution system as estimated for 1919	65,800
Total cash requirements	\$356,800
Debentures at 79.27 per cent, say	450,000
Interest on above at 4 1/2 per cent.	20,250
Sinking fund at 1.224 per cent.	5,508
Total fixed charges	\$ 25,758
Estimated gross receipts for 1919	219,400
Operating expenses	177,500
Net earnings	\$ 41,900
Interest and sinking fund charges on debentures issued for abandoned hydro-electric work . . .	\$ 59,800
Interest and sinking fund charges on additional investment for steam plant, etc., as above . . .	25,758
Total deductions	\$ 85,558
Deficit	43,658

The above deficit compares with the estimated surplus of \$13,027 shown for 1919 on the assumption that the hydro-electric development is completed and the full capacity of 4,000 E.H.P. sold.

As we have previously pointed out there is the further possibility that if eight months' power can be sold, the estimated surplus of \$13,027 under the hydro-electric plan might be increased by about \$9,000. These figures, of course, are contingent upon success in inducing industrial plants to locate in Prince Albert which will absorb all of the available power.

The completion of the hydro-electric development presents the possibility that it could be made more than self-sustaining, neglecting the \$17,000 fixed charges on present electric investment, whereas the steam plant alone at the assumed rates for power would show an annual deficit which would have to be made up by taxation.

If the industrial power is not sold under the steam plan No. 1, the results would be bettered as follows:

Gross (less discounts)	\$145,400
Operating expenses	95,000
Net earnings	\$ 50,400
Fixed charges	65,558
Deficit	\$ 35,158

With the steam plant the industrial power at \$30 per H.P. costs approximately \$37.50 for generation alone, leaving out of consideration distribution and general expenses.

Under Plan No. 2, making no attempt to sell industrial power

at low rates, but confirming operations to ordinary lighting and small power business at present rates, the addition of a 1,000 K.W. steam turbo-generator unit with auxiliaries, in place of the smaller existing unit, would give a capacity of approximately 1,500 K.W., or sufficient to carry the estimated lighting and small power peak for 1919. The estimated cost of this would be about \$46,000, and allowing \$55,600 for extensions to distribution system, etc., require a total of \$101,600 cash, which equals, say \$128,000 debentures. The results would then be as follows:

Gross (less discounts)	\$145,400
Operating expenses	95,000
Net earnings	50,400
Interest and sinking fund charges on \$128,000 debentures	\$ 7,327
Fixed charges on debentures issued for abandoned hydro-electric work	59,800
	67,127
Deficit	\$ 16,727

Summarizing, a comparison follows:—

	Surplus	Deficit
Completing Hydro-Electric Development, and assuming industrial power can be sold	\$13,027	
or	\$22,027	
Ditto, but industrial power not sold	\$46,000	
Building steam plant of 4,000 E.H.P. capacity and industrial power sold (No. 1)	43,658	
Ditto., but industrial power not sold	35,158	
Increasing present steam plant by 1000 K.W. unit (No. 2)	16,727	

In all of the above cases a further yearly fixed charge of about \$17,000 should be considered due to the investment in the present steam plant and distribution system, but this does not affect the comparison.

A decision as to the best course to pursue, therefore, depends on whether manufacturing industries can be induced to locate in Prince Albert to an extent sufficient to absorb the power we have been considering. We regard success in this as quite doubtful, and further feel that this uncertainty would render it difficult to sell the large amount of debentures required for the hydro-electric completion.

Our reason for thinking it improbable manufacturing industries can be induced to locate to any considerable extent in Prince Albert is that other elements of manufacturing cost than power would be unfavorable, such as high wages and lack of plentiful labor, and high freight rates on raw material and finished products. This latter would perhaps not be true as regards raw material for pulp making, but rates on the outgoing pulp would we believe make it non-competitive with other sources of supply. As Prince Albert is on the edge of the wheat growing section, possibly some milling in transit might be done profitably. Saw

mills as a market for power are unpromising because of the large amount of waste available for fuel. The severe winter weather conditions also make the heating of industrial plants expensive.

In our opinion the best course to pursue is the last plan above considered, i.e., to increase the present steam plant as the business demands, and not attempt to complete the hydro-electric development until definite contracts for industrial power can be secured or some other very definite assurance obtained that the power can all or largely be marketed. Steps should be taken to protect the uncompleted work from damage as far as possible.

IX. SUMMARY AND CONCLUSION

Taking up the question which in particular you wish answered, as set forth in paragraph 9 of your letter of November 27, 1913, it is evident that it was had in mind in framing these particularly sales of power for industrial purposes. The power required for lighting and small metered power business is, however, so closely related to the other that the two must be treated together in any consideration of the subject.

Question (a): "The final and total cost of the present development when completed as now laid out for the present capacity, stating separately the amount already expended, including the cost of a suitable steam reserve plant erected in the City limits, suitable receiving and transforming station in the City, and all transmission lines and connections, the above items being separately given, and including all expenses in obtaining capital such as discount, commissions, and fees, and allowances for contingencies."

Answer: The cash requirements will be as follows, the corresponding 4½ per cent. debentures worked out in the body of our report being \$2,816,000. These latter do not cover the net operating deficit prior to 1919, assumed to be taken care of by taxation or otherwise.

	Expended to Jan. 1, 1914	Total Cost Completed to Jan. 1, 1916	Total Cost to and including 1919.
Construction and other ex- penditures except as below	\$788,868	\$1,924,825	\$2,004,775
Interest and sinking fund...	39,504	228,121	859,305
Net earnings credit		65,200	587,500
	<hr/>	<hr/>	<hr/>
	\$828,372	\$2,087,746	\$2,276,580

Question (b): "The tariff on which you would advise the sale of power, including prices for nine months' power and restricted hours' power, bearing in mind that the City is prepared to face some loss on operation in order to secure increase of population."

Answer: We advise that the present tariff for general lighting and small power business be continued, or if it is found desirable to change the details thereof, to do so in such a way that the same total returns would be secured. Industrial power to be sold at the following rates based on ordinary maximum demand, these being adopted because they are low, considering the cost of steam generated power in Prince Albert, and being such as to make the proposition about break even in the annual results when all the

capacity is sold. If the City is prepared to stand an annual loss, the industrial power rates might be reduced to an extent to be governed by the amount of such loss, and such alternative rates could then be readily determined from the detail figures of our report:

Primary or first class industrial power \$30 per H.P. per annum, ordinary maximum demand.

Second class, or "off peak" industrial power \$20 per H.P. per annum, ordinary maximum demand.

No considerable amount of nine months' power would be available, but there would be eight months' power to the extent of about 1,750 H.P. at the customers, for which a rate of \$12 per H.P. is recommended. To have this available, however, would require a cash expenditure of \$166,600, beyond that set forth in the answer to question (a), for the necessary equipment to produce it.

Question (c): "The probable demand for and actual sale of power of the different classes over a series of years according to your judgment of the reasonable probabilities."

Answer: Our estimate of the probable demand and power sales is as follows:

Industrial Power					
End of Year	xLtg and Small Metered Power	xxPrimary	xxOff Peak		
			Secondary		
1914 ..	1,070 H.P.				
1915 ..	1,220 H.P.				
1916 ..	1,295 H.P.				
1917 ..	1,390 H.P.	1,100 H.P.			
1918 ..	1,500 H.P.	2,200 H.P.	400 H.P.		
1919 ..	1,670 H.P.	2,200 H.P.	400 H.P.		

xAt Substation. xxAt Customers.

The above does not include possible sales of 1,750 H.P. eight months' power mentioned in answer to question (b).

Question (d): "The annual financial result over the same series of years, showing the cost to the City per H.P.-year sold."

Answer: The annual financial results we estimate as follows:

Year	Surplus	Deficit	
1915 ..	34,700		for in construction figures.)
1914 ..	\$30,500		(Fixed charges provided
1916	\$69,163	
1917	43,850	
1918	8,898	
1919 ..	13,027		

The method of arriving at the preceding figures is shown in detail on pages 32 and 33 of the report, and a study of these will show that it is impracticable to figure what the cost of the industrial H.P. alone would be to the City per year, because of the intimate relation with the power required for lighting, etc.

If eight months' secondary power as above mentioned is sold at \$12 per H.P., surplus earnings would be increased by about \$9,000 per annum, after allowing for fixed charges on the additional investment involved.

The above figures do not take into consideration a further fixed charge, which in 1913 was about \$17,000 on the present investment in the steam plant and electrical distribution system.

QUESTION (e) AND ALSO QUESTION (f):

"(e) Ditto, if the present expenditure is taken as lost and it is considered only whether the further expenditure necessary to complete the work would be justifiable."

"(f) The measures, if any, that would advise the City to take to improve the present situation."

Answer: The wording of question (e) is somewhat obscure, but our interpretation of its meaning leads us to consider these two questions as one. We have shown in the body of the report that if the hydro-electric development is completed and the surplus power sold for industrial purposes at the rates recommended, the proposition will be about self-sustaining. But if such surplus power cannot be sold there will be a deficit of about \$46,000 per annum, and a preferable plan, in case such power cannot be sold, would be to add only as required to the capacity of the existing electric property to take care of the growth of lighting and small power business, as this would involve only an annual deficit of \$16,700. This deficit takes into consideration the fixed charges of \$59,800 on the investment in the hydro-electric development to be abandoned. This latter plan has the further advantage of requiring the raising of only a very small fraction of the additional money which would be required for the completion of the hydro-electric development.

The decision mainly rests, however, upon whether the surplus power can be sold for industrial purposes, and we are of the opinion that ability to do this to any considerable extent is very doubtful, because of the difficulty of inducing manufacturing plants to locate in Prince Albert in the face of high wages and lack of plentiful labor, and high freight rates on raw material and finished products.

We therefore recommend that only such increases be made to the present steam plant and distributing system as the growing business demands, and that the completion of the hydro-electric development be not undertaken unless contracts or other very definite assurances are secured that a market can be had for all or most of the surplus available for industrial power at reasonably satisfactory rates. Such protection against damage as is possible should be given the uncompleted work.

We believe the data collected in our investigations to be reliable and our estimates and recommendations based thereon to be sound and conservative.

Very truly yours,

THE J. G. WHITE ENGINEERING CORP..

(Signed) H. S. COLLETTTE,
Secretary.

